UNIVERSITY RESEARCH AND DEVELOPMENT

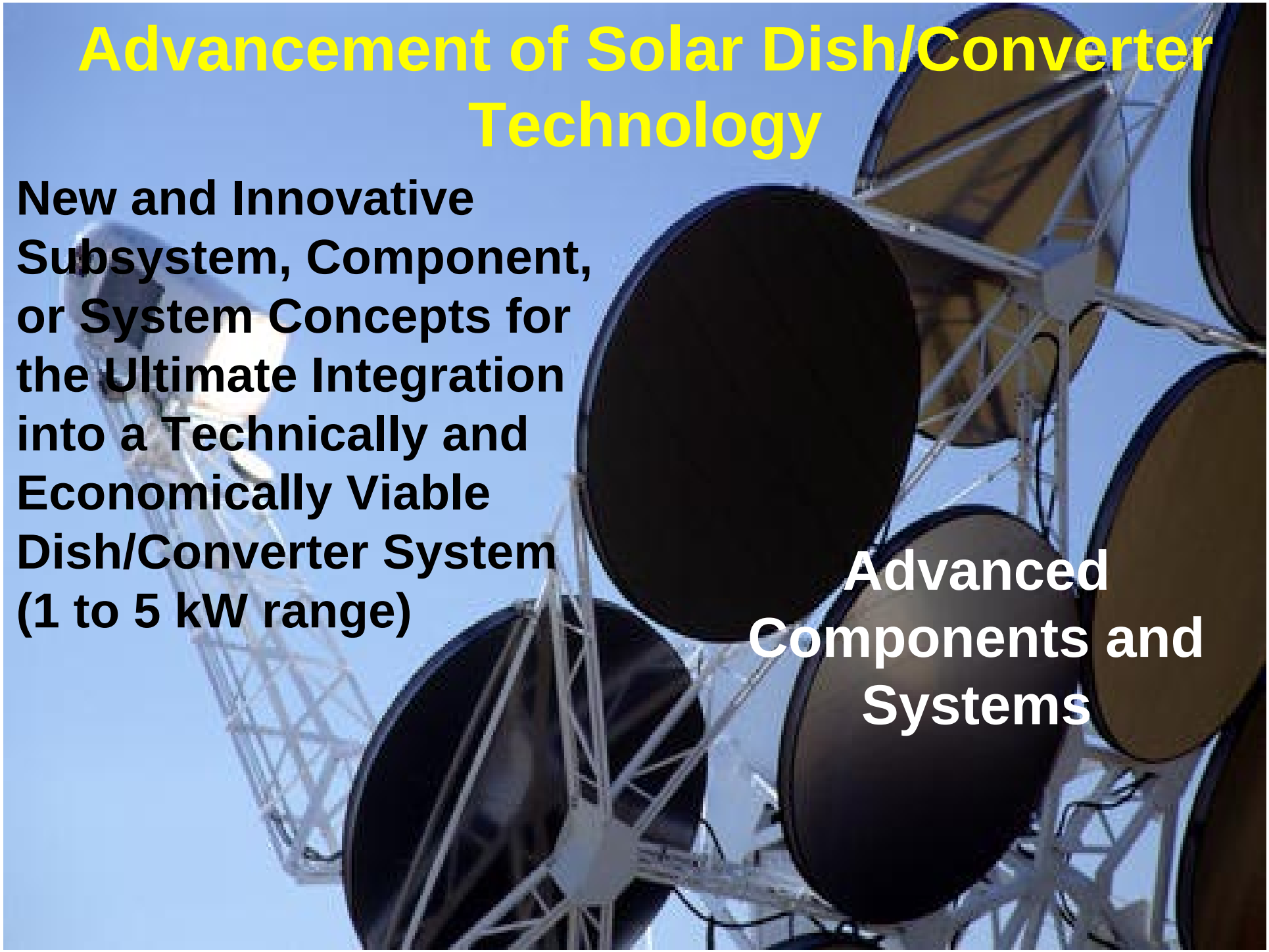
Advancement of Solar Dish/Converter Technology

Path #3: Advanced Components and Systems

November 8, 2001

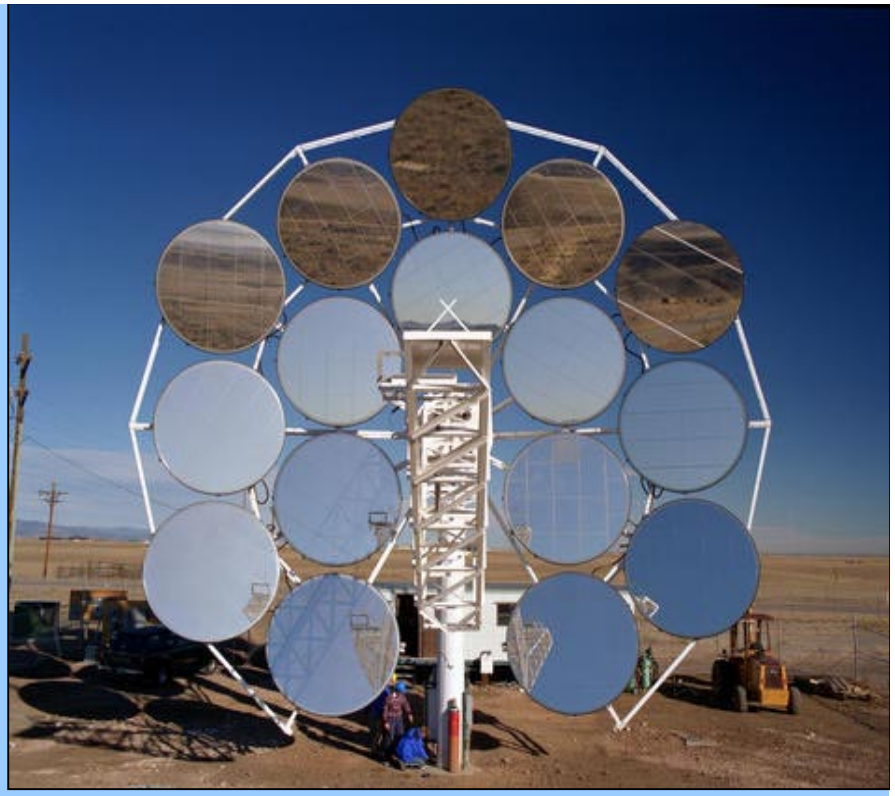
Advancement of Solar Dish/Converter Technology

New and Innovative Subsystem, Component, or System Concepts for the Ultimate Integration into a Technically and Economically Viable Dish/Converter System (1 to 5 kW range)



Advanced Components and Systems

University Research Advancement of Solar Dish/Converter Technology



Solicitation Objectives

Fundamental Research to Advance Existing Technology for Improved Performance, Increased Reliability, and Reduced Cost

Develop New System Concepts and to Demonstrate System or Component Performance through Test, Modeling, or Analysis

University R&D Solicitation

Three Universities Selected

- Cleveland State University
- Drexel University
- Oregon State University

Due to Limited Funding, Oregon State University was not Awarded an Agreement under the Solicitation

Cleveland State University

"Redesign of the Regenerator through Experiments, Computation and Modern Fabrication Techniques"

- Three-year Cooperative Agreement (09/00–08/03)
- Valued at $663,715 (DOE $541,000-Fully Funded)

Drexel University

"Modular PV Power System Using Solar Fiber-Optic Mini-Dish Concentrators"

- Two-year Cooperative Agreement (1/01-12/02)
- Valued at $646,401 (DOE $527,668-Funded for FY01)

University Research

Cleveland State University

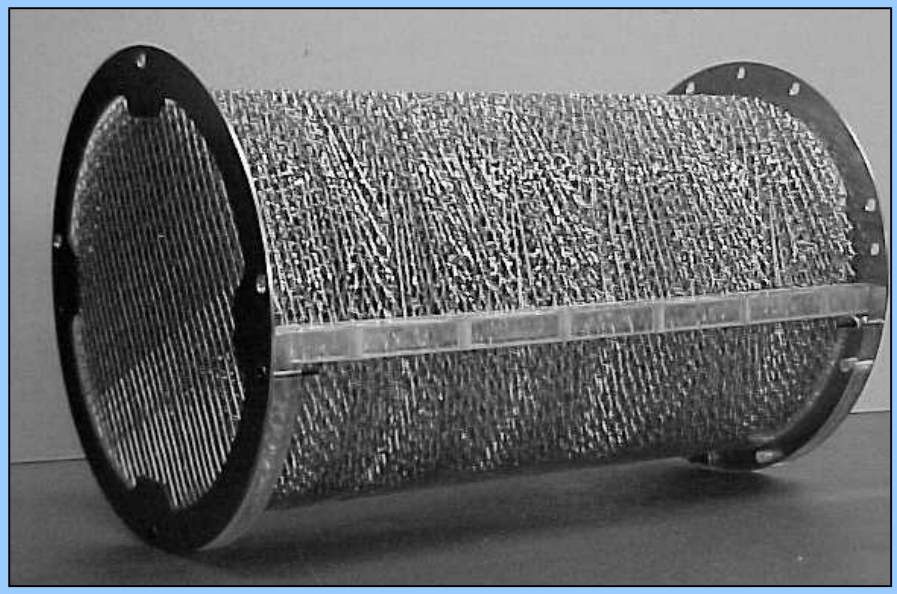
Regenerator Efficiency, Identified by Industry, as One of the Obstacles to Improving Stirling Efficiency

Research Goal

Increased Efficiency through Reduction of Pressure Drop Losses Across the Regenerator

Focus

Random-Fiber Metal Felt for Regenerator Matrix



Pressure Drop Losses Due to the Regenerator Amount to About 11% of Thermal Inefficiency

University Research

Cleveland State University

"Redesign of the Regenerator through Experiments, Computation and Modern Fabrication Techniques"

Participants

- Cleveland State University (Dr. Mounir Ibrahim)
- University of Minnesota (Dr. Terry Simon)
- NASA Glenn Research Center (Dr. Roy Tew)
- Gedeon Associates (David Gedeon)

Industrial Partners

- Stirling Technology Company (STC), Washington State
- Sunpower Incorporated, Ohio
- Bekaert Fiber Technologies-North American Division,Belgium Corp.

University Research

Cleveland State University

"Redesign of the Regenerator through Experiments, Computation and Modern Fabrication Techniques"

Approach

- Measurements (UMN Oscillatory Flow Test Facility and CSU Experimental Facility)
- Fabrication of Regenerator Test Section
- Sage Modeling (1-D Stirling Engine System Model)
- Advanced Computational Fluid Dynamics Models
- Development of Design Rules (Plenum Space, Porosity and Bypass Controls)

University Research

Cleveland State University

"Redesign of the Regenerator through Experiments, Computation and Modern Fabrication Techniques"

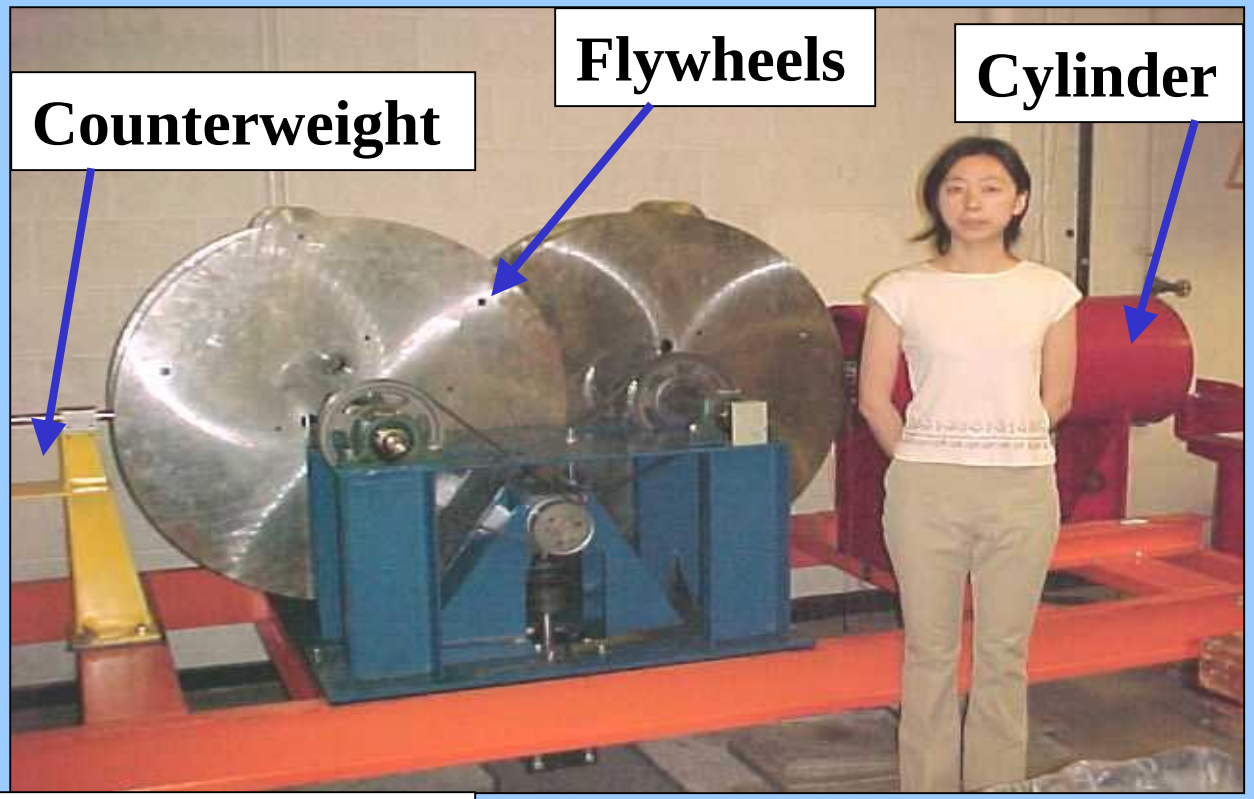
Status

- Completed Computational Fluid Dynamics Simulation-Complex Geometries/Porous Media (04/01)
- Finalized Regenerator Test Section Design (05/01)
- Fabricated Regenerator Matrix (06/01)
- Initiated Base Case Regenerator Testing (10/01)

Experimental Facilities

University of Minnesota Test Rig

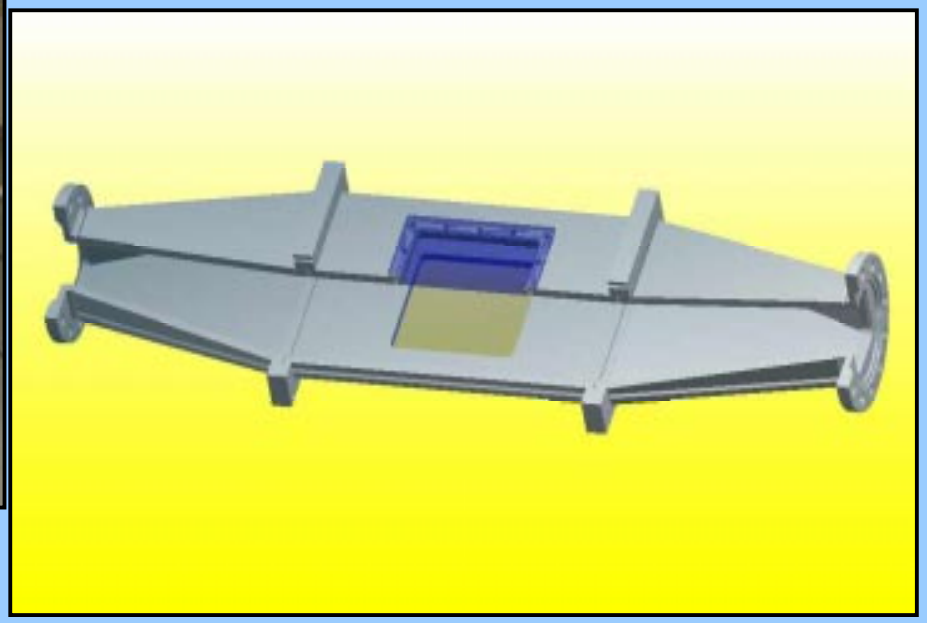
Oscillatory Flow Drive – This scotch-yoke mechanism drives a piston in the cylinder to give oscillatory flow crossing the plane to the right - on which the test section is mounted.



Experimental Facilities

Stirling Laboratory Research Engine Test Rig (Scale & Frequency Similar to Stirling Engines)

Photo of Test Rig



Test Module

University Research

Cleveland State University

"Redesign of the Regenerator through Experiments, Computation and Modern Fabrication Techniques"

Next Steps

- Begin Testing Full Size Regenerator at CSU (06/02)
- Complete Base Case Regenerator Testing at UMN (07/02)
- Complete Computational Fluid Dynamic Modeling (06/02)

Issues

- None

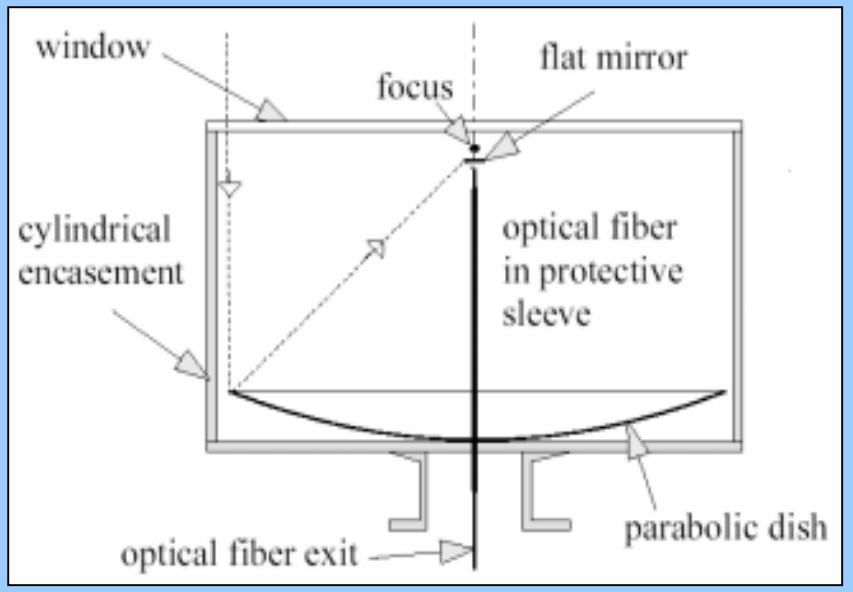
University Research

Drexel University

“Modular PV Power System Using Solar Fiber-Optic Mini-Dish Concentrators”

Research Goal

Experimental Realization of a Conceptual Innovation in Modular Collection and Delivery of Solar Energy with Small Dishes for Photovoltaic Power Generation



University Research

Drexel University

"Modular PV Power System Using Solar Fiber-Optic Mini-Dish Concentrators"

Phased Approach

- Design, Production, Assembly, Test, and Demonstration of Prototype Mini-Dish Concentrators (Year 1)
- Design, Assembly and Operation of 1 kWe Prototype System (Year 2)

Planned Net Conversion Efficiency of One-Kilowatt Photovoltaic Power Plant in Excess of 20%

University Research

Drexel University

"Modular PV Power System Using Solar Fiber-Optic Mini-Dish Concentrators"

Participants

- Drexel University

  Dr. Agami Reddy, Civil and Architectural Engineering

  Dr. Kevin Scoles, Electrical and Computer Engineering

  Dr. Bruce Eisenstein, Electrical and Computer Engineering

Collaborators

- Ben-Gurion University of the Negev, Israel

  Dr. Daniel Feuermann

  Dr. Jeffrey Gordon

University Research

Drexel University

"Modular PV Power System Using Solar Fiber-Optic Mini-Dish Concentrators"

Phase 1 Objectives (CY 2001)

- Complete Design, Fabrication and Procurement of Components
- Design and Fabricate High Concentration Indoor Solar Simulator
- Indoor Component Testing
- Assembly of Prototype Mini-Dish Concentrators
- Design of Data Collection System
- Outdoor Testing and Monitoring of Prototypes

University Research

Drexel University

"Modular PV Power System Using Solar Fiber-Optic Mini-Dish Concentrators"

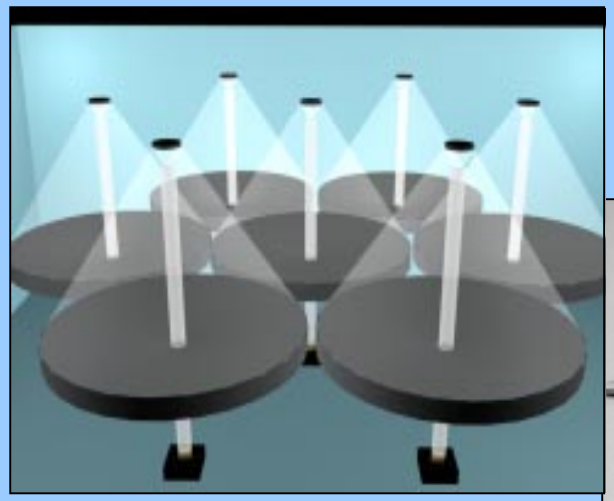
Status

- Prototype Design Finalized (03/01)
- Completed Solar Simulator Design - 1000 Suns (05/01)
- Software Developed for Evaluating Mechanical and Optical Design (05/01)
- Completed Ray Trace Simulations (08/01)
- Outdoor Testing of Tracker Completed (09/01)
- Completed Mini-Dish Concentrator Prototype (09/01)

University Research

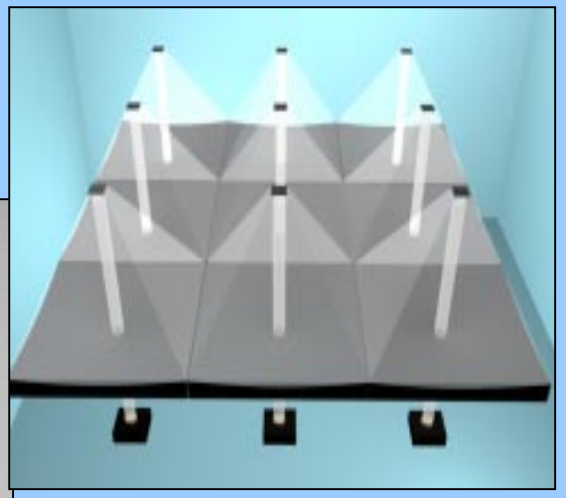
Drexel University

“Modular PV Power System Using Solar Fiber-Optic Mini-Dish Concentrators”



Module with Circular Mini-Dishes

Photograph Parabolic Mirror



Module with Square Mini-Dishes

Drexel University

“Modular PV Power System Using Solar Fiber-Optic Mini-Dish Concentrators”

Prototype Mini-Dish and Tracker Assembly

University Research

Drexel University

"Modular PV Power System Using Solar Fiber-Optic Mini-Dish Concentrators"

Next Steps

- Complete Assembly of Prototypes (2), Pending Receipt of Solar Dishes
- Complete Testing of Mini-Dish Concentrator Prototypes
- Begin Phase 2, Design, Assembly and Operation of 1 kWe Prototype System

Issues

- FY02 Funding to Complete Phase 1 (Continuity of Funding)
- Phase 2 Funding (FY02 Appropriations)